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A New Class of High Strength Molding Resins

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6. AUTHOR(S)

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Maxdem Incorporated
140 E. Arrow Hwy.
San Dimas, CA 91773

8. PERFORMING ORGANIZATION REPORT NUMBER

NA

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Advanced Research Projects Agency
A New Class of High Strength Molding Resins
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10. SPONSORING / MONITORING AGENCY REPORT NUMBER

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13. ABSTRACT *(Maximum 200 words)*

Maxdem has developed a novel family of thermoplastic resins, designated Poly-X(TM), which demonstrate exceptional strength and modulus. PolyX(TM) is based on a new type of rigid-rod polymer structure which combines good mechanical properties with facile processibility. Therefore, parts can be molded from Poly-X(TM) resins by a variety of common molding techniques and are projected to possess ultra-high mechanical strength and stiffness. Composites fabricated with Poly-X(TM) resins are expected to have unprecedented compressive strengths due to the high modulus of the Poly-X(TM) matrix resin. During the proposed Phase I work, initial experiments will be performed to demonstrate suitable fibermatrix adhesion for composite applications and that high strength parts can be molded. Work has begun to prepare the quantities of polymer required to perform these tasks and to fabricate test samples to allow evaluation of the fiber-resin interfacial properties. During the Phase II work, new composites will be fabricated which are projected to possess significantly enhanced compressive strength compared to the current state-of-the-art.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Composites, Compressive Strength, High-Strength, Matrix Resin, Molding Resin, Molecular Composite, Rigid-Rod Polymers, Self-Reinforced Polymers, Thermoplastic.	
	16. PRICE CODE: NA

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Maxdem Incorporated
140 E. Arrow Hwy.
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909-394-0644

A NEW CLASS OF HIGH STRENGTH MOLDING RESINS
PHASE I
Monthly R&D Status Report

SPONSORED BY
Advanced Research Projects Agency
Defense Sciences Office
ARPA Order No. 7755
Program Code No. 3S10
Issues by ARPA/CMO under Contract #MDA972-93-C-0029

Effective Dt.:	*March 15, 1993*
Expiration Dt.:	May 15, 1993
Report Period:	03/15/93 - 03/31/93
Principal Inv.:	Mark Trimmer, Ph.D. 909-394-0644
Author:	Mark Trimmer 909-394-0644

Contract No.: MDA972-93-C-0029
Contract Start Date: March 15, 1993
Monthly R&D Status Report

Technical Progress

Initial work under this Phase I program has begun and has proceeded as planned. Maxdem researchers have begun efforts to prepare the polymers required during the course of the Phase I research. Thus far, sufficient quantities of Poly-X™ resins have been produced to begin to examine wetting and adhesion with carbon fibers. Within the next month, we project that the bulk of the materials required to complete both the processing and fiber adhesion studies will have been prepared. We anticipate no problems in preparing the required Poly-X™ derivatives.

Initial fiber-resin test samples have been prepared by combining various types of carbon and glass fiber tows with powdered Poly-X™ resin and consolidating (compression molding) into a small panel. Modifications which can be examined include fiber type, surface treatments, sizings and coupling agents, and processing conditions combined with different Poly-X™ derivatives (either different resins or resins modified by various types of additives such as plasticizers, thermosetting components, adhesion promoters, etc.). During the Phase I effort, studies will be limited to a series of basic fiber types (AS4, IM7, T300, and T650/42 carbon and S-2 Glass® fibers) and a single Poly-X™ resin which, however, will be modified by various types of additives.

The fracture surfaces of the consolidated fiber-resin test panels are examined by microscopy (optical and SEM) for qualitative evaluation of the fiber-matrix interfacial characteristics. Preliminary results obtained with the S-2 Glass® fibers appears to be very promising, and a Poly-X™/S-2 Glass® composite will likely be one of the first to be prepared. Samples prepared with the various types of carbon fibers will be sent for SEM analysis within the next two weeks, and results are expected within the next month. Considering the early success with glass, we anticipate no problem in identifying at least three promising combinations for composite fabrication during the Phase II effort.

Efforts are proceeding to coalesce a team of collaborators experienced in composite components, fabrication, and testing to aid in the Phase II efforts. Preliminary discussions have been held with researchers at Hercules, Amoco Performance Products, Hexcel, BASF Structural Materials, Quadrax, Custom Composites Materials Inc. (CCMI), Georgia Institute of Technology, Michigan State University, and Wright-Patterson Air Force Base. The makeup of the Phase II research team should be decided within the next few weeks.

No processing of test coupons aimed at optimizing mechanical strength has been attempted yet, awaiting synthesis of the appropriate polymers. Most of these processing studies should be completed within the next month, including the compression molding and an initial attempt to prepare an extruded sample. Mechanical properties of initial samples will have been obtained by the end of the next month, but those of second-generation optimized samples may require somewhat more time. We anticipate no problems in fabricating the samples, obtaining the measurements, or meeting the stated goal of 325-375 MPa flexural strength.

FNDRPT1.WK3

DATE PREPARED: 04/01/93
CONTRACT NO: MDA972-93-C-0029
CONTRACTOR: MAXDEM INCORPORATED

FUNDS AND MAN HOUR EXPENDITURE SUMMARY

WORK PACKAGE TITLE SUMMARY
REPORTING PERIOD: MARCH93
EST. COMPLETION: 31APRIL93

	A		B		C		D			E	F
	ORIGINAL NEGOTIATED CONTRACT		LATEST NEGOTIATED CHANGES		REPORT PERIOD EXPENDITURES		CUMULATIVE EXPENDITURES			ESTIMATED COST TO COMPLETE	LATEST COST ESTIMATE
	A1	A2	B1	B2	C1	C2	D1	D2	D3		
	MAN HRS	$ VALUE	MAN HRS	$ VALUE	MAN HRS	$ VALUE	MAN HRS	$ VALUE	% $ VALUE		
1. DIRECT LABOR											
PRINCIPAL INVESTIGATORS	120	$3,806			64	$1,933	64.0	$1,933	50.80%	$1,861	$3,794
RESEARCH ASSOCIATES	82	2,256			84	2,148	84.0	2,148	95.22%	$100	$2,248
RESEARCH ASSISTANTS	142	2,835			8	155	8.0	155	5.47%	$2,752	$2,907
MAXDEM COST SHARING											
PRINCIPAL INVESTIGATORS						0	0	0	0.00%	0	
RESEARCH ASSOCIATES					(38)	(922)	(38)	(922)		+22	
RESEARCH ASSISTANTS							0.0				
TOTAL LABOR	344	$8,897			118.0	$3,317	118.0	$3,317	37.27%	$5,633	$8,949
OVERHEAD + FRINGE BENEFITS	////////	22,242	////////		////////	10,591	////////	10,591	47.34%	11,780	$22,371
2. TOTAL LABOR AND OVRHD	////////	31,139	////////		////////	13,908	////////	13,908	44.41%	17,413	31,320
3. SPECIAL TESTING	////////	3,500	////////		////////	0	////////	0	0.00%	3,500	3,500
4. TRAVEL EXPENSES	////////	500	////////		////////	0	////////	0	0.00%	500	500
5. OTHER DIRECT COSTS	////////	0	////////		////////	0	////////		0.00%	0	0
6. SUB-TOTAL COSTS (SUM OF 2 THRU 5)	////////	35,139	////////		////////	13,908	////////	13,908	39.58%	21,412	35,320
7. G&A COSTS	////////	9,965	////////		////////	4,745	////////	4,745	47.35%	5,277	10,022
8. TOTAL COST (SUM OF 6 & 7)	////////	45,104	////////		////////	18,653	////////	18,653	41.14%	26,689	45,342
9. FEE (OR PROFIT)+ FCC MONEY	////////	4,863	////////		////////	2,044	////////	2,044	44.19%	2,581	4,625
TOTAL CONTRACT AMOUNT (SUM OF 8 & 9)	////////	49,967	////////		////////	20,697	////////	20,697	41.42%	29,270	49,967
OUTSTANDING COMMITMENTS	////////		////////		////////		////////		////////		
TOTAL COMMITMENTS AND EXPENDITURES	////////		////////		////////	$20,697	////////	$20,697	////////		49,967